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California Bearing ratio of Black Cotton Soil use Waste Copper Slag: A Study

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Abstract: Use of waste substances in road creation has been in style in India for pretty some time. This is in particular necessitated with the aid of the troubles of disposal related to it. Otherwise, those materials might motive issues to the surroundings. In this research paper end result CBR fee of Black cotton soil use waste copper slag. Copper slag is one waste byproduct produced by means of The Sterlite Industries-I Ltd. New Delhi (SIIL), India. The manufacturing of copper slag is 120-a hundred thirty lakh ton in keeping with annum.Copper producing units in India depart thousands of lots of copper slag as waste every day, granulated copper slag is extra porous and, consequently has particle size same to that of coarse sand. The previous research studies carried out by various researchers on utilization of copper slag in clayey soil consequences for properly soil stabilizations 2% to 30%. Further, we use this ratio of black cotton soil. We use copper slag to determine CBR values of black cotton soil

Keywords- Copper Slag (CS), Black Cotton soil (BC), MDD, OMC and CBR test

I. INTRODUCTION

Soil stabilization is the process in improving the engineering properties of soils and thus making it more stable. It is essential when the soil accessible for construction is not suitable for the anticipated purpose. In its broadest sense, stabilization included compaction, reconsolidation, drainage and many other such process .However, the term stabilization is generally restricted to the processes which alter the soil material itself for improvement of its properties a cementing material or a chemical is added o a natural soil for the purpose of stabilization. Is to improve the natural soils for the construction of foundations, highways and airfields. Soil stabilization is used to reduce the permeability and compressibility of the soil mass n earth structures and to increase its shear strength. Soil stabilization is of stab required to increase the bearing apacity of foundation soils. However, the main use of the principles of soils stabilization are used for controlling the grading of soils and aggregates in the construction of bases and sub-bases of the foundations, highways and airfields. Soils stabilization is also used to make an area trafficable within a short period of time for military and other emergency purpose. Sometimes, soil stabilization is used for city and suburban streets to make them more noise-absorbing. The expansive soil is a very problematic soil these soils occur in up to 3.7m depth on average in India. The black soil is occupying nearly 30% of area. The black soils contain various sever our problem just like more shrinkage more swelling less strength and stability and having volumetric change. Based upon the seasonal change to avoid these problem used. Admixtures like poly propylene, polyethylene etc, the waste material occur from manufacture process these material are create not only environment problem but also create the hazardous and disposal problem that why to avoid this problem these waste material are used in the strengthens soils s admixtures are stabilization in the form of admixture. These are available in less cost or free of cost.

Expansive soil is a term generally applied to any soil that has a potential for shrinking or swelling under changing moisture conditions. Expansiveness is a phenomenon that affects many clay soils, particularly those that contain significant quantities of steatite clay minerals. The primary problem that arises with expansive soils is that deformations are significantly greater than elastic deformations and they cannot be predicted by classical elastic or plastic theory. Movement is usually in an uneven pattern and of such a magnitude as to cause extensive damage to the

structures and pavements resting on them. Expansive soils can cause more damage to structures, particularly light buildings and pavements, than any other natural hazard, including earth quakes and floods. Soil stabilization refers to the procedures employed with a view to altering one or more properties of soil so as to improve its engineering performance. The main objective of soil stabilization is to increase the strength or stability of the soil and to reduce its sensitivity to moisture changes. Soils can be stabilized by the addition of a small percentage of cement or Copper slag. Such stabilization processes enhance many of the engineering properties of the treated soils and produce an improved construction material. The use of recycled material to improve marginal soils offers a viable alternative from economical, technical, and environmental standpoints. Recycled materials provide an attractive alternative to traditional engineering construction materials such as asphalt, concrete, natural aggregate and others. This is due in part to their suitable engineering properties, which allow them to be used as substitute materials in several transportation and geotechnical applications. Equally important, recycled materials offer both economic and environmental incentives.In addition to a lower cost in comparison to traditional materials, their use has the potential to alleviate landfill problems as well as avert costs typically associated with their disposal.

II. RELATED WORKS

Akshaya Kumar Sabat and Subasis Pati says that Expansive soil is a problematic soil for civil engineers because of its low strength and cyclic swellshrink behaviour. Stabilization using solid wastes like copper slag, blast furnace slag, mines waste etc., is one of the different methods of treatment, to improve the engineering properties and make it suitable for construction. The beneficial effects of some prominent solid wastes as obtained in laboratory studies, in stabilization of expansive soils.

R C Gupta, Blessen Skariah Thomas, Prachi Gupta, Lintu Rajan and Dayanand Thagriya studied that Copper Slag is one of the waste byproduct produced by 'Hindustan Copper limited', Khetri, Rajasthan, India. The production of Copper Slag is 120-130 lakh ton per annum. Expansive soils are a worldwide problem that creates challenges for Civil Engineers. They are considered as potential natural hazard, which can cause extensive damage to structures if not adequately treated. The disadvantages of clay can be overcome by stabilizing with suitable material. This research was done on the engineering behavior of Clay when stabilized with Copper Slag Prof. Jinka Chandrshekhar and Timir A Chokshi discussed that Copper slag is one of the waste materials that are being used extensively in the civil engineering construction industry. Copper producing units in India leave thousands of tonnes of copper slag as waste every day. Large quantities of the accumulated slag is dumped and left on costly land, causing wastage of good cultivable land. Based on U.S. environmental protection agency regulations, governing solid waste characteristics, copper slag can be classified as a non-hazardous material. Granulated copper slag is more porous and, therefore, has particle size equal to that of coarse sand. In this paper, a review of the previous research studies carried out by various researchers on utilization of copper slag in geotechnical applications is discussed and presented.

Isaac Ibukun Akinwumi discussed that Elemental and chemical analysis of the steel slag was determined using x-ray fluorescence spectroscopy. Tests were carried out to determine the index properties, compaction characteristics (maximum dry density, MDD and optimum moisture content, OMC), strength characteristics (California bearing ratio, CBR and unconfined compressive strength, UCS) and permeability of the natural and treated soil. Test results show that Atterberg limits (liquid limit, plastic limit and plasticity index) generally decreased, while specific gravity of soil – steel slag mixtures increased with higher steel slag content; MDD and OMC increased and decreased, respectively, with higher steel slag content. Generally, CBR and UCS increased up to 8% steel slag treatment of the soil.

Permeability of soil – steel slag mixtures increased with higher steel slag content. Based on laboratory test results, an 8% optimal stabilization of the A 7-6 soil with steel slag satisfactorily meets the Federal

Republic of Nigerian General Specifications (Roads and Bridges) requirement for subgrade materials.

III. THE PROPOSED APPROACH

Copper Slag: Copper slag were collected from the Sterlite Industries-I Ltd. New Delhi, India, in collection, the physical properties of copper slag were explained in Table 1 and chemical composition in Table 2 and shown in Figure 1.

Table 1: Physical Properties of Cooper Slag

S.No.	Physical Properties	Value
1	Particle shape	Irregular
2	Appearance	Black & glassy
3	Specific gravity	2.9-3.9
4	% of voids	43.20%
5	Bulk density	2.08 g/cc
6	Fineness modulus	3.47
7	Angle of internal friction	5' to 20'
8	Moisture content	0.10%
9	IS classification	SP

Note: Data from - Birla Copper Unit Industries, Dahej. Gujarat, India.

Table 2: Composition of Copper Slag

Chemical Property	(% wt)
Iron oxide (Fe_2O_3)	42-48
Silica(SiO_2)	26-30
Aluminum oxide(Al_2O_3)	1.0-3.0
Calcium oxide(CaO)	1.0-2.0
Manganese oxide (MgO)	0.8-1.5

Black Cotton Soil: Black cotton soil were collected from Shri G S Institute of Technology & Sciences, Indore, MP. The soil was used in experimental program and it was classified as high compressibility of clay (CH) according to Indian Standard Soil Classification System (ISSCS). The physical properties of Black cotton soil were explained .

Grain Size Analysis: Copper slag has carried out as per Indian Standard procedure (IS2720 part-4). The particle-size distribution of Copper Slag is obtained with the help of sieve analysis. The particle size distribution curve was shown in Figure 2 and BC. Soil size distribution curve was shown in Figure 3.

Figure 1: Granulated Copper Slag

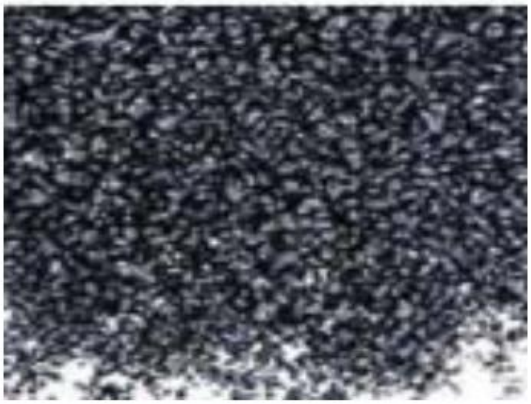
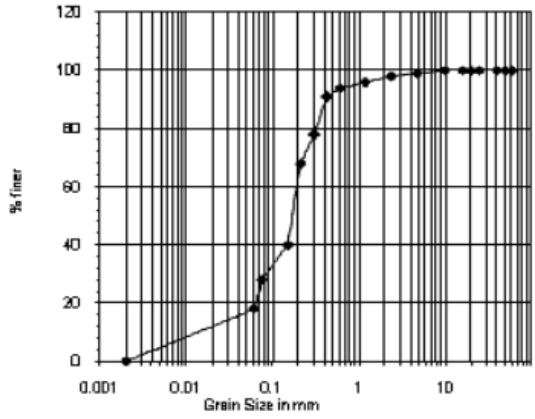


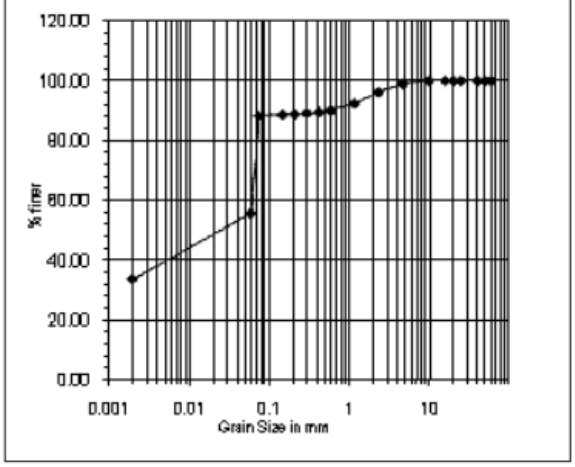
Figure 2: Particle Size Distribution Curve of Copper Slag



Chemical Analysis Report: The chemical composition of CaO = 26%, MgO = 0.8%, SiO_2= 26%, Fe_2O_3= 42%, Al_2O_3 = 1% and loss on ignition = 4.2%. The combined percentage of silica, alumina, and iron oxide in copper slag as natural pozzolana as per ASTM C618 (1999). Therefore, Copper Slag was expected to have good potential to produce high

quality pozzolanas very less amount of MgO (0.8%) The summation of silica, alumina, Calcium, Magnesium and iron oxide in copper Slag was 95.8%. So, it has good potential to produce high quality pozzolanas.

Figure 3: Particle Size Distribution Curve of BC Soil



Mechanical properties: Compaction Characteristics Standard Proctor Test was carried out as per Indian Standard Procedure (IS:2720 part-7). The Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) of the BC soil are found as 18% and 1.58 g/cc and for combination 68% BC soil with 32% CS was 18% and 1.90 g/cc.

California Bearing Ratio Test: California Bearing Ratio (CBR) test was carried out as per Indian Standard procedure (IS 2720, Part-16). It was observed that soaked CBR (4 days) values of combinations of BC soil and copper slag were in the range 1.98 - 5.43%, while CBR values of 72% BC soil with 28% CS have high CBR value 5.43% and further it tends to decrease. CBR was 5.32%, 70% BC soil with 30% CS combination and CBR was 5.26%, 68% BC soil with 32% CS combination, tends to, decrease the results.

V. CONCLUSION

On the basis of this take a look at and observations made, the conclusions are as follows:

• The aggregate BC soil with CS (2% to 32% copper slag) the MDD of range 1.64 g/cc to at least 1.9g/cc are will increase. High value mof MDD 1.9 g/cc and OMC 18% in the mixture of 68% BC soil with 32% copper slag.

• It becomes determined that soaked CBR (4 days) values of mixture BC soil with CS (2% to 28% copper slag) are increases and in addition, it has a tendency to lower. High price of soaked CBR 5.43% in aggregate of 72% BC soil with 28% copper slag. High CBR the fee as compared to BC soil and satisfied the PWD standards to be used in subgrade/sub the base layer of street pavement.

• Copper slag with 22% to 32% can be combined with tricky soils to enhance or alter the soil traits.

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